

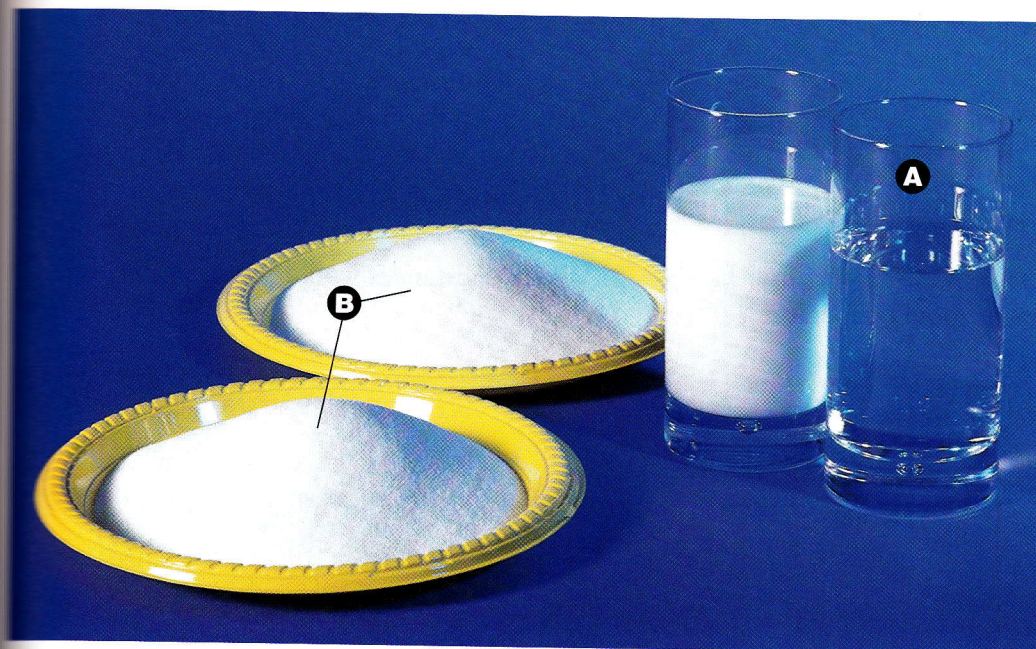
A Formula for Density

The density of a substance can be determined by calculating its mass-to-volume ratio. You can do this by dividing the object's mass by its volume. Therefore, the formula for density is:

$$\text{Density (D)} = \frac{\text{Mass (m)}}{\text{Volume (V)}} \text{ or simply, } D = \frac{m}{V}$$

For example, the density of an object having a mass of 10 g and a volume of 2 cm³ is 5 g/cm³. The density of solids is usually given in g/cm³ (grams per cubic centimetre). The density of liquids and gases is often given in g/L (grams per litre) or g/mL (grams per millilitre). Using pure water as an example, you could express its density as either 1 g/cm³ or as 1 g/mL (1 cm³ = 1 mL).

As long as the temperature and pressure stay the same, the mass-to-volume ratio, or density, of any pure substance is a *constant*, which means it does not change.



Word CONNECT

Density is an example of an *intrinsic property* of a pure substance, because density depends only on the particles that make up the substance. Intrinsic properties can be used to identify pure substances, because each pure substance has its own specific set of intrinsic properties. Therefore, you could measure the density of a pure substance to help determine its identity. Name two other intrinsic properties of a pure substance.

A Seawater may look like regular water, but its density is closer to that of milk — 1.03 g/mL.

B The salt and sugar shown here both have a mass of 0.5 kg and are the same colour. However, their densities differ.

You observed the property of density in Conduct an Investigation 5-A. When you increased the volume of each substance, the mass increased. Therefore, the mass-to-volume ratio, represented as a decimal value, remained constant. If the mass of a pure substance increases, the volume will increase. Similarly, if the volume of a pure substance increases, the mass will also increase. According to the particle theory, the size of the particles of a substance does not change when the mass or volume of the substance changes. A certain number of particles of a particular size will always occupy a certain space. As the number of particles increases from substance to substance, the space required for those particles must also increase. Therefore, density is a property of matter that is unique to a specific pure substance. Table 5.1 lists the approximate densities of some common substances at 0°C and 101.3 kPa of pressure.

Table 5.1 Approximate Densities of Common Substances

Fluid	Density (g/mL)	Solid	Density (g/cm ³)
hydrogen	0.00009	styrofoam	0.005
helium	0.0002	cork	0.24
air	0.0013	oak	0.70
oxygen	0.0014	sugar	1.59
carbon dioxide	0.002	salt	2.16
ethyl alcohol	0.79	aluminum	2.70
machine oil	0.90	iron	7.87
water	1.00	nickel	8.90
seawater	1.03	copper	8.92
glycerol	1.26	lead	11.34
mercury	13.55	gold	19.32